

# Market Guide for Indoor Location Services

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Vendors continue to offer many different technologies and architectures to locate information about people and assets inside buildings. I&O leaders must understand usage scenarios and total cost of ownership and can use this research to help guide their indoor location options.

## Key Findings

- Many usage scenarios exist for indoor location services. They differ in the types of people or assets being tracked whose location is needed to improve not only a business process, but also the granularity that is required to make better business decisions, such as optimized maintenance and staffing.
- Many different methods exist for determining indoor location, including different architectures, technology and algorithms.
- More than 80% of Gartner clients required multiple technologies to address all of their location requirements.
- Security and management of beacons or location-sensing devices are important architectural considerations for all indoor location services.

## Recommendations

I&O leaders should:

- Not select an architecture, specify radio frequency or process flow until you document and understand all of the usage scenarios in which location is needed to avoid deploying partial solutions.
- Perform a wide-ranging TCO assessment to understand all the components needed for an end-to-end solution.
- Evaluate if there are multiple usage scenarios in which the technology can be leveraged.

## Strategic Planning Assumption

By 2020, more than 30% of enterprises will use location services to track staff or assets, up from less than 10% today.

## Market Definition

The market consists of vendors that supply hardware and software components that provide on-premises location services to a breadth of organizations that include both enterprises and public venues. These components typically include:

- **Hardware:** Beacons, including active RFID tags and supplemental beacons (Bluetooth or other); fixed readers; Wi-Fi access points; and other components, such as wireless bridges that provide connectivity to Wi-Fi or wired switching, depending on the architecture
- **Software:** Location engines or client applications that assist in providing location information and may be located on-premises or in the cloud.

These components are used to create three major on-premises location service solutions in the market: static/fixed beacon location applications; mobile assets using beacons to address zonal requirements; and mobile and fixed assets with real-time location requirements.

## Static/Fixed Beacon Location Applications

Static/fixed beacon location solutions use physical or virtual beacons that are placed throughout the organization/building and communicate information to devices in the proximity of where the beacon is located. This is the usage scenario that is mentioned most often when clients discuss location services via Gartner inquiries. This Market Guide covers the beacon technology, management, security and location engine that are required to provide on-premises location services, but it does not address application development toolkits or client applications that may use the location services (this will be discussed in a separate Market Guide report). There are two basic ways that beacon information is used:

- In the first solution, the beacon provides information, such as location, to an application that is loaded on a mobile device. In a hotel, casino or convention center usage scenario, the beacon signal may indicate the device is in front of a theater or restaurant and provide the end user with showtimes, menu information or a coupon via a downloaded application. In a healthcare environment, such as a hospital, or shopping mall usage scenario, the beacon may provide specific location that is used by a navigation application on the client device to locate a patient room or store. In each of these scenarios, the beacon broadcasts information about its location that is used by an application on a mobile client to provide the requested end-user information.
- In the second solution, the beacon broadcasts a website, such as Google's Eddystone. In a transportation usage scenario, the beacon could direct the end-user browser that supports the Eddystone extensions and displays the appropriate bus or train schedule. Additionally, provided that there is broadband (internet) connectivity for the end-user device, a beacon in front of a restaurant could also point to the appropriate menu on the restaurant website.

## Mobile Assets Using Beacons to Address Zonal Requirements

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There are situations in which the organization does not want an asset, person or thing to leave a particular area, such as a lab, data center, hospital floor or plant entrance/exit. In these situations, with zonal requirements, rather than have a static beacon with a mobile reader, the reader is fixed and the beacon is mobile. The reader can be mounted into each egress or doorway, and it time-stamps the beacon as it moves through the reader field. Some usage scenarios have the readers turn on video cameras, depending on the asset, and capture the identity of the person leaving with the asset, while others may capture all employees leaving a chemical plant to ensure that everyone has exited a building or location in the case of a dangerous situation.

## Fixed and Mobile Assets With Real-Time Location Requirements

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Real-time location solutions are another situation in which the beacon is on the asset and not statically affixed to a single location. The requirement, as the name denotes, is to know where the asset is at all times instead of in a specific instance in time (which is the zone solution). Historically, a real-time location system (RTLS) has had the highest level of Gartner inquiries but has fallen off in the past couple of years because either the price point to achieve the less than one meter (m) — three feet — accuracy was too high for the project or the wireless infrastructure could only guarantee 5 m to 10 m accuracy.<sup>1</sup> Today, many solutions use supplemental beaconing as another point of to enhance the performance of Wi-Fi.

## What Has Changed?

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In the last year, we have seen significant changes in the market, as organizations look to solve their business challenges to know where people and assets are located. As we reviewed our Market Guide from 2015 against our client inquiries, it became apparent that there are different decision makers and challenges associated with indoor location services and outdoor solutions, where GPS was used in conjunction with the mobile devices. While there was some overlap in the high-level business needs, indoor location solutions focused more on asset management or wayfaring, while many outdoor location solutions focused on transportation management, such as geofencing, mapping and logistics.

Additionally, as we reviewed the different types of location solutions, we found that there are differing vendors, organization requirements and decision criteria for location services compared with location toolkits, accessories (such as mapping solutions) and vertical market applications. While we recognize that some vendors provide a complete end-to-end solution for their target vertical market, we will cover them appropriately in both Market Guides.

With the location service market, there have been several noteworthy changes. The first is a different usage scenario for location services that highlights both new architectures and new technologies. The second is the different types of messages that beacons are messaging. Traditionally, beacons broadcast a static message, but new solutions allow them to broadcast the URL of a website.<sup>2</sup> Lastly, we are seeing organizations pay more attention to physical management and security of beacons as part of the overall solution life cycle. This is also reflected in the trend we have been observing in the past two years: Many vendors have decided to take ownership of the

Bluetooth beacons by making their own branded products. Even though this means a substantial investment for some smaller companies, it delivers certain advantages, the main ones being quality assurance, security and configuration control, and a more complete product offering.

## Market Direction

We continue to see new, smaller vendors trying to claim their niche in the market alongside larger, more established vendors. This situation is typical for a young market, and we anticipate market consolidation during the next 36 to 48 months, as evidenced by the recent acquisition of Ekahau by AiRISTA in 1Q16. As larger, more established current enterprise players are figuring out the market, smaller vendors, especially pure technology vendors, will get absorbed by these larger enterprise players, such as Cisco or Hewlett Packard Enterprise (HPE).<sup>3</sup>

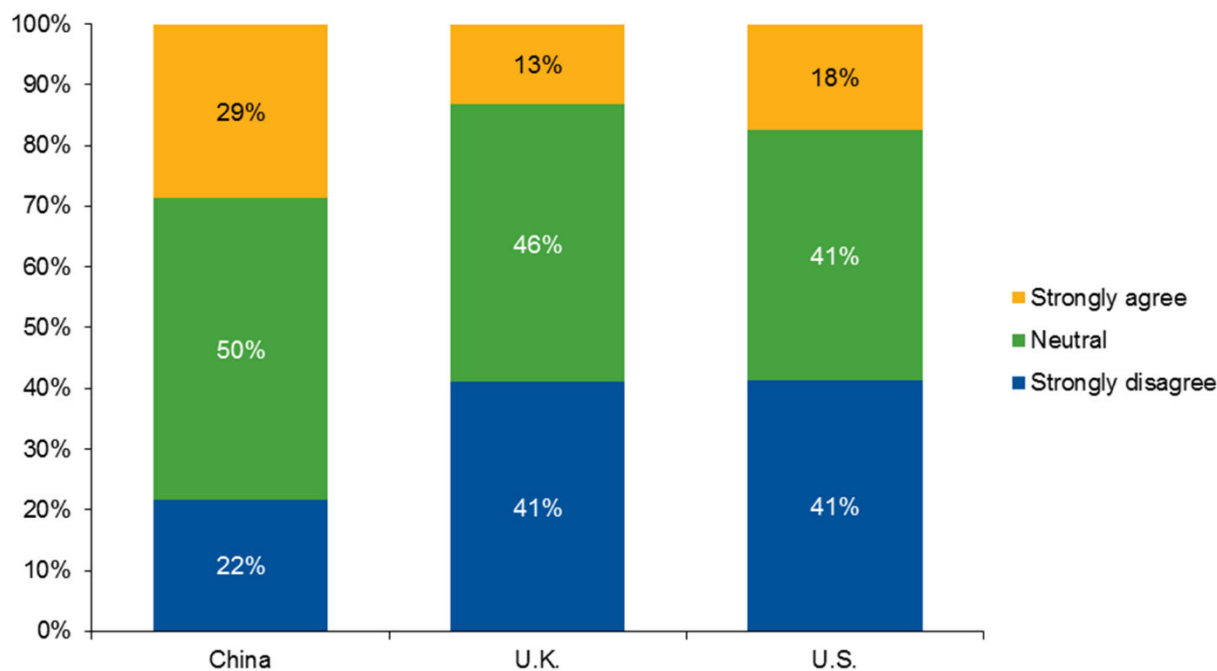
Furthermore, as part of this emerging market, many smaller players may not reach profitability, may run out of funding or specialize on a specific niche, making them less interesting for customers outside the niche.

From a provider perspective, product diversity is seen from the solution architecture all the way down to the beacon frequency, protocol or messaging. Vendors are also looking to differentiate in their business models, whether it is through their channel strategy, strategic partnerships or vertical market solution.

Overall, vendors continue to address market concerns by enhancing security features in their offerings to prevent spoofing and to make communication between beacons and mobile devices safe. Even here, for securing and managing the beacon infrastructure, there is no standard approach, but vendors have enabled security in several different ways. Some of the different approaches, such as proprietary encryption methods, are discussed in the Representative Vendors section.

Privacy concerns continue to emerge during discussions with vendors and IT leaders alike, as there is still uncertainty about how users may react to personal messaging in the retail environment. The good news is that, in the healthcare environment, there is a strong business case for patient wayfinding and messaging, as these reduce the no-show rate in hospitals, as some studies have shown. Gartner conducts user surveys each year to understand mobile users' attitude toward technology. Figure 1 reveals the results of a 2015 study, in which we asked respondents to indicate how much they agree or disagree with several statements. We found differences in how mobile users in China versus the U.K. and the U.S. feel about apps tracking their location. It shows that Chinese users feel more comfortable than users in the U.K. and the U.S. to share their location when value is received in exchange. While these results are directional, it is difficult to measure such attitudes, as many respondents respond to a question in a way they feel is appropriate, especially when it is about privacy, rather than saying how they really feel.

Figure 1. Responses Related to Location Tracking



Note: Respondents were asked to indicate if they agreed or disagreed with the following statement: "I am willing to have my location tracked by apps if I get additional features or convenience by doing so."

Source: Gartner (May 2016)

## Market Analysis

The indoor location service market continues to be fragmented. Vendors use many different radio technologies and architectures to provide location services to enterprises. Additionally, these solutions may require an overlay of radio coverage that is often different from existing Wi-Fi. These differing solutions are often the result of existing vendor solutions not being able to address the granularity or business requirements of organizations that need location information about people and assets to increase productivity in the business processes.

The need to address multiple usage scenarios in the same vertical market — and often in the same organization — is also masking the complexity of location requirements. While healthcare and retail seem to be the most popular markets for the vendors that we researched, we also found them to be some of the most complex. For example, in a cursory review of hospitals, we found more than eight different usage scenarios requiring location information for static, zonal and RTLS requirements. To meet these requirements, vendors provided three or more different radio frequency options, most requiring separate network connectivity.

To address these complexities, we found that vendors took several approaches. Some focused on point-level location solutions with open APIs to allow for integration with other vendors for

aggregation, user interface and reporting. Others provided a complete end-to-end capability that required deep knowledge of targeted vertical markets.

Architecturally, there was also a lot of diversity: Some vendors used off-the-shelf hardware, such as beacons or existing Wi-Fi connectivity, while others required their own proprietary hardware to assure their ability to address management and security concerns for their location data. Solutions varied on their requirement for on-premises hardware or cloud-based compute and storage resources, and while many vendors continue to move to the cloud, we expect that there will be specific vertical market best practices that drive this requirement. Furthermore, we expect that the vendor ecosystem will place an important part of the implementation for either installation of an end-to-end solution or integration with upstream third-party applications that may aggregate one or more technologies, or to develop the client-specific application using the vendor's software development kit (SDK).

The visibility in many of the vertical markets has raised the issues of gathering location data. In many usage scenarios and in the next couple of years, we expect advances in which vendors will be able to provide differing technologies that address the needs of the differing usage scenarios within a single vertical. As beacon hardware becomes commoditized, beacon protocols and data formats will become software selectable as a beacon option; we expect in three to five years that the solutions will be focusing on beacon management and security as part of solution platforms or gateways.

## Representative Vendors

*The vendors listed in this Market Guide do not imply an exhaustive list. This section is intended to provide more understanding of the market and its offerings.*

**NOTE:** *Some of the vendors are smaller players in the market and have limited visibility and penetration outside of their core markets and geographies. Clients should validate the ability of the vendor to meet their requirements and its local support capabilities that may be supplied by the vendor or through its channel partners.*

### Aruba, a Hewlett Packard Enterprise Company

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Aruba is a global leader for Bluetooth Low Energy (BLE) indoor location services. Aruba's Mobile Engagement Solution combines in-house enterprise-grade BLE beacon hardware and an industry-leading mobile app platform — called Meridian — that manages, monitors and secures beacons and beacon data to allow customers to build a cross-platform mobile app from scratch or to enhance an existing mobile app with location-based features, such as indoor "blue dot" navigation and proximity-based push notification. Aruba also uses a small Wi-Fi and BLE sensor that can be used for beacon communications and management, in addition to the existing BLE-enabled access points. It is one of the first end-to-end solutions to offer multivendor, remote beacon management tools.

The Meridian platform is a cloud-only solution that contains several elements, including Meridian Editor and AppMaker, SDKs and Aruba Location Services. The location service solution is powered

by Aruba Beacons to integrate real-time data, and the granularity of location is determined by the installation.

In addition to delivering the back-end technology for indoor location services, the Meridian platform includes the Meridian Editor content management system. The Meridian Editor houses aggregate analytics data for Aruba Beacons.

Aruba is one of the largest vendors in this research and should be shortlisted for any global indoor location service opportunity using BLE beacons.

## Awarepoint

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Awarepoint is an RTLS vendor that, in 2015, introduced its next-generation RTLS based on BLE and Wi-Fi. The solution delivers high accuracy and low latency, which are needed for workflow optimization applications. Location can be processed directly on a Bluetooth-enabled phone or tablet with a mobile location engine or processed through an on-site location engine. Awarepoint focuses on the healthcare market but is expanding its focus to the manufacturing and retail segments.

Awarepoint has developed an Intelligent Beacon offering that includes enterprise beacons and high-accuracy beacons. The offering includes asset, staff, patient, environmental and sterilizable tags to meet the needs of RTLSs in healthcare environments. The Awarepoint system not only accepts, manages and stores Awarepoint asset location feeds, but also uses its service-oriented architecture to receive and assimilate third-party geolocation feeds for asset management, temperature/humidity monitoring, wayfinding/mobile engagement, and clinical/operational workflows.

Awarepoint's back-end location engine determines traditional RTLS tag-based location via an on-premises location appliance. Depending on the infrastructure coverage level, the location engine will use either Wi-Fi or BLE-based location information to determine location. Awarepoint is unique in that it also has a mobile location engine that is part of its mobile SDK that does the location processing on the mobile device.

The on-site location appliance drives Awarepoint's cloud-hosted software tools, including System Manager, which is used to configure the solution and govern the communication to the Awarepoint cloud for access to analytics and reporting tools, and awareHealth, which provides the customer-facing interface for asset management and temperature monitoring, as well as third-party APIs for location integration into other systems. All beacons and tags support enterprise-level Wi-Fi security that is set up when new beacons/tags are provisioned by the Awarepoint support team.

Awarepoint should be considered for any health provider that is both looking for real-time staff, patient, asset and/or mobility-based tracking requirements in North America and looking to deploy cloud-based applications.

## Beaconinside

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Germany-based Beaconinside launched in 2014 its first products targeting the retail industry, smart cities/public transport and hospitality. The current geographic focus is EMEA, but the vendor has a

global presence, with its second most important region being North America. Beaconinside's go-to-market strategy focuses on the enter/exit scenario of mobile users in venues and proximity-based location services of 5 m by 5 m.

Beaconinside's offering is composed of its proprietary Bluetooth beacons, SDKs and APIs, and a hosted cloud-based system for analytics. The 2.4GHz beacons are mounted on fixed locations and serve as a proximity tool of an area of 5 m by 5 m, rather than pinpointing someone to a specific location. The vendor was the launch partner of Google Eddystone, and its beacons are also iBeacon-certified. The Beaconinside proprietary management platform has the ability not only to manage its own beacons, but also to monitor and manage third-party BLE beacons. The platform is designed to manage large multivenue installations of beacons, and tools are provided to uniquely identify each beacon. With the beacon manager apps (available for Android, iOS and Mac), the beacon signal frequency can be individually configured from 50 milliseconds to every 10 seconds. In addition, groups of beacons can be configured separately to send out different advertising messages. Encrypted authentication methods are used to secure the beacon network.

The solution is device-centric, as it is part of the SDK working in online and offline mode directly within the mobile client. The company does not have a specific analytics product, but location data for a business intelligence product is hosted in the cloud.

Beaconinside should be considered for BLE-based targeted interactions with consumers in retail or other (public) places where 1 m accuracy is not required.

## Cisco

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Cisco is a global leader for Wi-Fi and BLE indoor location services. Cisco's CleanAir technology embedded in Cisco Aironet access points gives Cisco Wi-Fi access points the ability to monitor, decode, classify and locate BLE beacons from third-party vendors. Connected Mobile Experiences (CMX) is the common platform for location where Wi-Fi and BLE location come together. CMX location technology can be deployed with either Cisco's Aironet (on-premises) or Meraki wireless (cloud-managed) infrastructure. As of March 2016, CMX Cloud offers customers a new SaaS consumption option for location services. Cisco Wi-Fi location solutions deliver a broad range of location accuracy based on customers' needs, from Presence (15 m to 20 m), FastLocate (5 m to 7 m) to Hyperlocation (1 m to 3 m). Another equally important location metric is the location refresh rate. Cisco has the ability to increase the location refresh rate of the beacons by introducing technologies, such as CMX FastLocate, to rapidly calculate location. CMX FastLocate is now available on all models of Cisco access points.

All deployment options provide REST APIs that enable a broad ecosystem to support market-specific mobile application needs in retail, hospitality or healthcare. Tags supplied by Cisco partnerships not only are used for asset location, but also can be integrated with motion, temperature, humidity and voltage sensors to meet any real-time locating requirements.

Cisco's CMX location engine can manage, monitor, detect and analyze standard Wi-Fi, BLE and Hyperlocation Wi-Fi signals. Beacons are discovered, identified, configured and located by the CMX location engine. Communication from the CMX platform to access points or beacons is completed



through secure connections, and security is monitored by Cisco Wireless Intrusion Prevention System (WIPS).

CMX Analytics (location and presence) have been bolstered with a new, graphical interface. Customers can use the CMX Analytics dashboard to report peak times, average dwell times, peak and average device counts, and correlation and path analysis reports. CMX Analytics can also help businesses do testing so that organizations can capture the effect of store layout and customer dwell times very easily.

CMX Connect (captive portal) provides easy-to-deploy customized mobile engagement portals that are location-specific with templates, images and language support.

Cisco is the largest vendor covered in this research and should be shortlisted for any global Wi-Fi and BLE indoor location service opportunity.

## Estimote

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New York-based Estimote has been providing a solution, including Bluetooth beacons, since 2013. The vendor has a global customer base, with more than 50% of revenue being derived outside the U.S. in 2015. Estimote's primary target audiences are the retail industry, cultural/civic institutions (for example, museums and sports arenas), and the hospitality industry.

Estimote provides an end-to-end solution, including three types of Bluetooth beacons, SDK and APIs, a cloud-based beacon management platform, a location engine, and analytics. Based on the location, SDK customers reach an average positioning accuracy of 1 m. The different beacon products can be distinguished by performance and use case. Estimote Proximity beacons come with a three-year battery life, an accelerometer and temperature sensor, and iBeacon and Eddystone packet support. The Estimote Indoor Location beacons come with all those attributes, as well as a seven-year battery life, the ability to support general-purpose input/output (GPIO) connectivity for hardware prototyping, more sensor support for Estimote's own packet types, and the ability to broadcast multiple packets simultaneously. The third type of beacons has a smaller form factor to be stuck on objects that potentially move and broadcast data about their location, as well as other sensor data. Here, zonal monitoring can also be applied to let the user know when a beacon has left or entered a predefined area. All beacons are being managed via the web-based Estimote Cloud platform.

At the heart of Estimote's offering is the location engine that can be on-premises or in the cloud, depending on customer preference. Estimote's security governance involves two layers: There is an authentication process and a rotating beacon ID to prevent unauthorized access to the beacon network. More security layers will be live in upcoming iterations.

Estimote Analytics Version 2.0 allows the user to track the number of unique visitors and the number of visits, as well as measures the dwell time and the interactions with individual beacons (action triggered), and monitors the beacon as it enters/exits a predefined area.

Estimote should be considered for any global Bluetooth-only-based retail and public location opportunity, in which consumers need to be targeted individually, as well as in the enterprise context for people/object monitoring.

## match2blue

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Germany-based match2blue offers Bluetooth beacon hardware and different sets of SDKs for indoor positioning and marketing campaigns. The vendor is currently focused primarily on the retail sector in Europe, but the solution can be applied to more environments, including hospitals, airports and events, among others.

Match2blue manufactures its own Bluetooth beacons, branded "blulocs." Signal strength and broadcast frequency can be customized as needed via the vendor's SDK. The range of the beacons can be extended to up to 100 m, which enables reaching mobile users before entering a certain venue. Beacon controllers, of which one or two are installed per venue, are cloud-based and monitor the beacon fleet. The administrator can use the smartphone app to receive alerts when something is changing, such as a battery change or a beacon has disappeared.

The SDK grants developers access to firmware of the beacons to develop applications or integrate beacon positioning into existing apps and loyalty programs. Indoor turn-by-turn navigation is also an option. Moreover, there is an SDK to create promotions and campaigns. With the web-based content management portal, the customer can enter promotions, with notifications pushed to the users' smartphones. The portal is also used to monitor user data in real time, such as dwell time and movement.

The final component is the data analytics product that provides insight into user behavior when interfacing with the beacons. The dashboard reveals dwell time and visitor frequency, as well as responses and conversion rates of a marketing campaign. In addition, match2blue entered a partnership with Computop, a mobile payment company that facilitates the check-out process, as it lets users pay at mobile registers in predefined areas.

Match2blue should be considered for any EMEA Wi-Fi and BLE-based retail environments or other consumer-facing contexts.

## Mist Systems

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Mist Systems is a global solution provider that is looking to redefine the indoor location service market by providing precise indoor positioning of sub-1 m (less than three feet) accuracy via a cloud-based machine-learning location engine. Mist Systems focuses on the retail, hospitality, healthcare and airport industries. Enterprises outside North America should verify local support through strategy partners in their region.

Mist Systems' virtual BLE (vBLE) array technology enables deployment of high-accuracy location-aware services. Mist Systems provides a multielement directional antenna as an extension to Mist Systems' Wi-Fi 802.11ac Wave 2 access points or existing strategy partner Wi-Fi access points. In addition to the access points, Mist Systems incorporates machine-learning algorithms in a cloud-based location engine. A Mist Systems vBLE access point broadcasts the BLE, AltBeacon or

Eddystone message to an application that has been enabled by the mobile SDK when the mobile client passes through a virtual beacon location defined by the location engine platform. The solution can also be used to deploy zonal applications using the same technology. The advanced machine learning algorithms continually adapts to the changing radio frequency (RF) signature to provide better, more unequivocal location information over time.

The solution can be used for the same use cases as physical beacons — for example, wayfinding (directions) and proximity marketing — as well as asset tracking for retail, healthcare, hospitality and transportation, such as airports. The solution provides cost, management and reduced-overhead benefits, including: no need for initial or ongoing site survey; no need to purchase beacons; no batteries to monitor or change; and no security or management issues associated with physical beacons. It also has the ability to dynamically reconfigure the location of the beacons.

The Mist Systems architecture is a cloud-based location engine that provides low latency location estimates at a very high scale. The machine-learning component of the location engine looks at data coming from mobile devices and continuously updates location information. Mist BLE Analytics enables customers to deterministically track dwell times and occupancy rates, over time distributions. These analytics can be used for measuring wait times in security lines at an airport, hospital or stadium. The analytics can be used to deliver business insights in the retail and hospitality sectors and other public-facing enterprises. The Mist mobile SDK is responsible for mobile device sensors data (for example, accelerometer) and sending this data back to the cloud location engine to provide updated real-time location calculations.

Mist Systems is one of the smaller vendors covered in this research and should be considered for any global retail, healthcare, hospitality or airport BLE indoor location service opportunity.

## Onyx Beacon

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With main offices in Germany and Romania, Onyx Beacon targets the banking industries, as well as the transportation and logistics sector for asset tracking. The company has a global footprint, but more than half of its revenue in 2015 was driven by the EMEA market, with North America being its second most important market.

The vendor's solution centers on its own BLE beacons, but it integrates well with other technologies, including Wi-Fi and GPS, and supports both Eddystone and iBeacon protocols (as well as its own protocol). The system reaches accuracy of 1 m to 3 m on average in static deployments. For asset tracking deployments, when the audio feature of the beacon is used, accuracy of 0.4 meters — or even below that — can be reached. The Enterprise Beacon has a longer battery life, a temperature sensor, and an audio feature (an 85 decibel [dB] buzzer) for asset tracking and presence detection. The specific advantage of this acoustic signal is that it reduces the time of asset locating, and it also lends itself to interesting new use cases (for example, accessibility for visually impaired people in public transport).

The cloud-based beacon management platform allows firmware updates over the air, and for large beacon fleets, there are batch configuration options to enable wide changes to be applied. To

prevent spoofing and unauthorized access to the network, Onyx Beacon uses beacon data encryption.

The location engine can be run in the cloud or on-site, depending on customer preference. The customers can take a modular approach, picking and choosing the different modules they may need for their specific use case: wayfinding, push messaging campaigns and geofencing. Analytics tools also measure footfall and track assets in real time, and they are important components of Onyx Beacon's offerings.

Onyx Beacon has a global installed base and should be considered primarily in EMEA; however, it also relies on strong partnerships in the Middle East and North America. Onyx Beacon should be considered for consumer-facing indoor use cases as well as enterprise-grade asset tracking opportunities.

## Pole Star

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French company Pole Star is an indoor location technology provider with deployments in North America and EMEA. The vendor's main target markets are the corporate campus, retail industry and transportation.

Pole Star's indoor positioning solution is a device-centric solution composed of the NAO SDK, delivering three services: indoor positioning, fine indoor geofencing and indoor location analytics. The NAO Cloud platform enables the setup and the monitoring of the solution, as well as provides data and NAO Analytics.

The NAO SDK includes an autocalibration feature to help the same level of performance, independent of the type of device or platform. The NAO SDK is available for iPhone and Android smartphones through a hybrid technology that combines BLE, Wi-Fi, advanced motion sensor fusion, GPS and map data.

The NAO SDK also features Pole Star's proximity detection solution that requires the NAO BlueSpot (a proprietary BLE beacon), offering an accuracy of detection between a few centimeters to several meters. The solution either can work in beacon proximity mode or can provide geofencing notifications. The latest generation of 2.4GHz BlueSpot beacons feature five-year guaranteed battery life, over-the-air firmware update and configuration, and support for the iBeacon and Eddystone protocols.

Because the solution is device-centric, there is no location engine required either on-site or in the cloud; the calculation is done directly on the device. The positioning database and application are hosted in the NAO Cloud and synchronized by the mobile application. The network of beacons is monitored remotely, and there are several tools available to onboard new beacons. The use cases for Pole Star's solution center on wayfinding (discriminating between aisle/room/subarea), geofencing notifications and analytics.

Pole Star's security is based on the positioning database being encrypted, which prevents spoofing. In addition, the NAO BlueSpot beacons have a proprietary authentication method to connect with the NAO Logger setup application and to access configuration and firmware for protection against hacking.

Pole Star should be considered for public wayfinding solutions (such as for airports, museums and malls), as well as for location, context information, and occupancy monitoring on a corporate campus based on BLE and Wi-Fi.

## Quuppa

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Quuppa is a spinoff of Nokia Research Center and was founded in 2012, but already it has more than 260 deployments in 27 countries, although it is focusing on the U.S., China and Japan. The projects range from small pilot deployments to large-scale deployments, such as hospitals and large retail stores. The Quuppa solution is an overlay solution that positions BLE indoor locators that communicate with Quuppa's Positioning Engine to provide an RTLS solution that leverages the angle of arrival positioning algorithms for Quuppa beacons and third-party beacons, which may include Android and iOS smartphones as trackable devices. Quuppa provides accurate positioning (down to a few centimeters) — even of fast-moving objects (for example, hockey puck and golf ball) in real time (down to 100 ms latency).

Quuppa provides an end-to-end positioning solution that includes locators, tags and the positioning engine, as well as tools for site planning, deploying and monitoring the system. It also provides an open API that allows partners to integrate their analytics and reporting applications. Furthermore, Quuppa provides an open tag development platform, allowing its partners to design and manufacture their own BLE sensors (tags), thus fulfilling their specific requirements on form factors or sensing capabilities. To date, Quuppa has been certifying multiple third-party sensor models in its target markets of healthcare, security and sports arenas.

The Quuppa Positioning Engine can be deployed on-premises or in the cloud, providing flexibility for partners and customers. The Quuppa Customer Portal works in conjunction with the Positioning Engine and provides access to the deployed system, including system status and alarms, as well as tag management. The system can be configured to track all compatible devices or only known devices. If only known devices are tracked, then tags are added to the system using Quuppa Site Planner & Deployer tool. The link between that portal and the locators is encrypted, and the data between the locators and the tags is signed for validation.

Quuppa is one of the smaller vendors covered in this research and should be considered for global BLE indoor location opportunities.

## Rx Networks

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Rx Networks' indoor location technology business unit is called Fathom, with its first product expected to be launched in 2Q16. The first customers of Fathom are expected to be in the U.S. and Europe.

Fathom's platform is composed of a network overlay of the Fathom Hub (that can be considered the location engine), APIs for services, a cloud-based remote control (Fathom Control) panel and analytics data. The platform not only monitors and manages (third-party) BLE beacons (supporting iBeacon and Eddystone), but also locates any type of Bluetooth-enabled device, such as wearables and smartphones. The Fathom Hub locates the beacons by comparing the angle of arrival and the

signal strength of each BLE signal from the perspective of two or more hubs. An important part of this locating process is the location of the hubs themselves. The Fathom Hub self-locates using a cloud-based location engine that incorporates GPS, barometric pressure and Wi-Fi-positioning. Once one Fathom Hub knows its coordinates, it will form a mesh network with other hubs and determine their location. Knowing the location of each hub is essential for locating any of the BLE devices. The Fathom Hub is authenticated via secure tokens in order to secure communication between all hubs and Fathom Control. The Fathom Hub is onboarded using a smartphone installation app, and because this requires an account within Fathom Control, there is no unauthorized configuration. The platform is also able to support RTLS-like tracking (for example, in hospitals or other environments where people or assets need to be tracked).

Rx Networks is one of the smaller vendors covered in this research and should be evaluated for North American or EMEA management of existing beacon deployments for both static and RTLS-like experiences.

## Sensoro

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U.S.-based Sensoro is one of the largest providers of beacons and has a wide global footprint. It is currently focused on the Asia/Pacific region in terms of number of deployments. More than half of its revenue is driven by its integration into WeChat in China, one of the largest social network apps in the world.

Sensoro offers a set of different BLE beacon products that support the latest Eddystone-EID specification. The beacon product family differs mainly in battery performance. The vendor has spent a lot of time and resources to optimize the quality and performance of its beacon hardware. One specific feature that stands out is a dual antenna, which is composed of the normal long-range antenna and paired with another short-range antenna that can provide more control on the accuracy of the signal coverage in usage scenarios.

The BLE beacons are monitored and managed via Sensoro's cloud platform. With the feature of anti-tamper security, the hardware-level customer passwords prevent malicious configuration, and give users full control and option to use or bypass Sensoro's cloud platform. The vendor's patented solution lets the beacons broadcast their battery status that can be collected by smartphone and centrally monitored via a dashboard.

Sensoro's latest product enhancement includes an edge reader, in which different environmental sensors (thermometer, humidity and so forth) are monitored by an Internet of Things (IoT) station (Alpha IoT station).

Sensoro is an emerging vendor covered in this research, and it should be considered for any global retail, museum or hospitality indoor opportunity.

## Stanley Healthcare

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Stanley Healthcare is a pioneer in the RTLS market that has focused on delivering solutions to healthcare clients for more than 30 years. It is a global provider, although the majority of installations are in North America. The end-to-end solution provides asset management, environmental

monitoring, patient flow, infant and patient protection, staff duress, and hand hygiene compliance monitoring.

Stanley Healthcare has developed a complete portfolio of 2.4GHz Wi-Fi healthcare tags designed to meet real-time locating requirements in any healthcare environment. Tags are used for patient, staff and asset location and security. Tag options provide motion, temperature and humidity monitoring capability. Stanley Healthcare offers standard integrations to voice over IP (VoIP), electronic medical records (EMRs), security systems, nurse calls and other systems.

The RTLS location engine for the AeroScout solution is deployed as an on-premises component that uses the received signal strength indicator (RSSI) and time difference of arrival (TDOA) for 2.4GHz Wi-Fi location calculations from any of its Wi-Fi partners. It also uses supplemental beaconing with other technologies, such as low frequency (LF) RFID and ultrasound, to address the location issues of the healthcare environment.

While Stanley Healthcare provides many vertical-market-centric healthcare applications that use the location engine to provide RTLS data through an external API, it also provides a business intelligence tool for the data that is collected. MobileView Analytics provides a data warehouse, dashboard and reporting abilities to present data near real time to make better decisions and optimize performance. The tags are able to support Wi-Fi Protected Access II (WPA2) security requirements and are managed by the MobileView application.

Stanley Healthcare is a large vendor that should be shortlisted for any hospital, senior living community or long-term care facility that is looking for global real-time patient and asset tracking requirements.

## Zebra

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Zebra has the most comprehensive portfolio of indoor location technologies and capabilities of the vendors that we reviewed. As a global provider, Zebra's Enterprise Asset Intelligence solution addresses the static, zonal and RTLS usage scenarios with Wi-Fi, ultrawideband (UWB), GPS and BLE, as well as passive and active 900MHz and 2.4GHz RFID.

Zebra's location solutions have the ability to integrate the input from multiple different technologies. This ability enables Zebra to deliver on a solution across a multitude of use cases in many verticals — including retail, industrial (transportation and logistics, warehousing, and manufacturing), healthcare and sports-related — that could be leveraging either one technology or a combination of underlying technologies. The location engine uses multiple algorithms, and Zebra claims accuracy from 3 m to 5 m using Wi-Fi down to 15 cm using UWB.

Zebra's location solution platform can be deployed on-premises, in a private cloud, as an Amazon Web Services (AWS)-hosted public cloud instance or as a managed service. The location platform includes analytics that both use machine-learning algorithms for asset classification and provides hourly, daily, weekly and monthly trending analysis. The open platform architecture allows the location platform to take any underlying location sensor input and pass it via APIs to a rich ecosystem of partners. Zebra offers a centralized view of management for any of its location

technology beacons, as well as sensors/receivers. The management application can be bundled with the location platform or deployed separately. Zebra has the ability to address the authentication and security needs for indoor location solutions, but it has different security mechanisms to address the broad portfolio of tags/beacons and receivers across the different frequencies and usage scenarios.

Zebra is a large vendor that should be shortlisted globally for all indoor location opportunities across all verticals.

## Market Recommendations

Many different technologies and algorithms can be used to determine location of people and assets. It is important that implementers document and understand all of the usage scenarios and how they will fit into their overall networking infrastructure strategy. In our research, we found that while clients were looking for "indoor location services," they often assumed it was one technology or solution that could accommodate all static, zonal and real-time location scenarios. Additionally, it was assumed that all location service functionalities were a single frequency for every usage scenario: More than 80% of clients<sup>4</sup> did not realize that multiple technologies could be used or may be needed to provide location information for the type of people or assets, or the granularity of location, that was needed.

Our research revealed that many vendors offered point-level solutions that addressed only a single business issue, such as direction finding/wayfaring or RTLS: Rarely were these solutions able to address all of the business issues (static, zonal and RTLS). We found this situation to be an issue in markets such as healthcare, in which there was not only a need for all three location service data capture solutions, but also a requirement for multiple frequencies — particularly in people-tracking scenarios, such as patient or infant tracking. Reviewing all of the usage scenarios also determined whether the solution could fit into the existing Wi-Fi infrastructure or required a separate overlay to meet the business needs. We found that organizations that understood all of their location service needs, reviewed them in conjunction with their current infrastructure capabilities and looked at the total cost of ownership (TCO) for the life of the equipment made location service decisions that met their needs and were able to set the correct expectations of the technology within their organization.

## Gartner Recommended Reading

*Some documents may not be available as part of your current Gartner subscription.*

"Best Practices for Implementing Beacons in IoT Solutions"

"Indoor Location-Sensing Technologies Enable New Contextual Experiences, 1Q16 Update"

"Maximize Customer Engagement With Location Technology"



Evidence

<sup>1</sup> Vendors' validated designs

<sup>2</sup> Google Eddystone

<sup>3</sup> Hewlett Packard Enterprise (HPE)

<sup>4</sup> 2015 Gartner inquiries

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